FINAL REPORT

SUBMITTED TO

JAY DORR
SAWTOOTH NATIONAL RECREATION AREA, KETCHUM, IDAHO
U.S. FOREST SERVICE

REGARDING

ESTABLISHMENT OF A LICHEN BIOMONITORING PROGRAM AND BASELINE IN THE SAWTOOTH WILDERNESS AREA, SAWTOOTH NATIONAL FOREST, IDAHO

COPY

PREPARED BY

LARRY L. ST. CLAIR Ph.D.
PROFESSOR OF BOTANY AND CURATOR OF NON-VASCULAR CRYPTOGAMS
DEPARTMENT OF BOTANY AND RANGE SCIENCE
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH 84602

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INTRODUCTION

PROJECT OBJECTIVES:

1. Identify and establish air quality bimonitoring reference sites in the Sawtooth Wilderness Area, Idaho. **(note: This objective was accomplished in 1988 and 1989.)**

2. Collect, curate, and identify lichen species from various habitats and substrates at each reference site. **(note: This objective was accomplished in 1988 and 1989.)**

3. Identify 3-5 pollution-sensitive lichen species at each reference site. Collect enough tissue of at least one sensitive indicator species (approximately 6-10 grams dry weight) from each reference site for elemental analyses. Rare species will not be sampled for analysis, but their distribution will be noted. **(This objective was accomplished in 1988 and 1989.)**

4. Determine baseline thallus concentrations of 20 potential pollutant elements (including sulfur, selenium, arsenic, copper, bromine, manganese, lead, vanadium, potassium, iron, etc.), using replicate samples of one documented pollution-sensitive species collected at each reference site. Samples will be analyzed using Proton Induced X-ray Emission (PIXE) techniques. **(note: This objective applies specifically to the 1993 reevaluation samples collected from Farley Lake and Alpine Lake. However, elemental analysis samples from 1988 and 1989 are currently being reanalyzed using PIXE technology. These data will allow for more meaningful comparison between the 1988-1989 samples and the 1993 samples.)**

5. Prepare and submit the final report by 31 December 1995. **(note: the orginal report was submitted in 1989; however, I have updated all of the original information into a more comprehensive format.)**

LICHENS AS BIOLOGICAL INDICATORS OF AIR QUALITY:

Protocol for using lichens as bioindicators of air quality is well documented (Fields & St. Clair 1984; St. Clair 1989; Richardson 1992). Hale (1983) noted that lichens have been used in three basic ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all (or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey along with elemental anlaysis of tissues from sensitive indicator species (St. Clair 1989; Wetmore 1989).

As lichens accumulate many different pollutants from atmospheric outwash, lichen tissues provide a record of the kinds and relative quantities of air pollutants in any particular airshed (Schutte 1977; Wetmore 1989; Rope & Pearson 1990) Pollutant accumulation patterns for specific elements have been monitored over time by correlating thallus growth rates and pollutant concentrations in excised portions of lichen thalli (Lawry & Hale 1981). Changes in lichen physiological processes indicate pollution-related damage long before other, more easily detectable changes in thallus color, morphology, or community structure become apparent (Fields & St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Rushforth et al. 1982; Wetmore 1989). As certain lichen species are inherently more sensitive to airborne contaminants, air quality can be effectively monitored by occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to original baseline data.

GENERAL HABITAT DESCRIPTION FOR THE SAWTOOTH NATIONAL RECREATION AREA AND THE SAWTOOTH WILDERNESS AREA:

The Sawtooth National Recreation Area was established in 1972 and consists of 754,000 acres. Included in the recreation area are three mountain ranges (the Sawtooths, White Clouds and Boulders) as well as parts of the Salmon River and Smoky Mountains. The mountain ranges of the Sawtooth National Recreation Area serve as headwaters for several major Idaho Rivers including, the Salmon, Big Wood, East Fork of the Salmon, Middle Fork of the Boise, and South Fork of the Payette. More than 400 lakes occur within the boundaries of the recreation area. The Sawtooth Wilderness Area includes 217,000 acres and encompasses most of the Sawtooth Range.

A significant portion of the recreation area is located within the southern portion of the Idaho batholith, called the Atlanta batholith. This granitic formation dominates central Idaho and was formed 70 to 90 million years ago during the late Cretaceous. Fresh exposures of this granite are pale gray and in some places slightly streaky. Weathered surfaces are pinkish brown due to an iron oxide stain that develops as the minerals weather. The most abundant mineral in this granite is a milky white feldspar; and the black flakes are biotite mica. The younger and much smaller Sawtooth batholith, formed 50 million years ago during the Eocene, forms a large part of the Sawtooth Range. Fresh exposures of the Sawtooth batholith granite are pink, with larger crystals and no streakiness.

Steep elevational gradients, massive rock outcrops compounded by the complicated topography of the recreation area has resulted in the development of a vast array of habitat types, ranging from alpine tundra and krummholz in the higher elevations to subalpine coniferous forests and riparian communities downslope.

LICHEN BIOMONITORING REFERENCE SITES IN THE SAWTOOTH WILDERNESS AREA:

A total of 6 air quality biomonitoring reference sites were established in Sawtooth Wilderness Area during the 1988-1989 field seasons. Two sites were reevaluated during the summer of 1993. Specifically, reference sites have been established at the following locations:

SITE #1: 25 July 1988. Idaho, Custer County, Sawtooth Wilderness Area: vicinity of Farley Lake, 43° 58' 44" north latitude; 114° 55' 52" west longitude. Elevation: 2377 m (7800 feet). Elemental analysis material reevaluated at this site, 23 August 1993.

SITE #2: 26 July 1988. Idaho, Custer County, Sawtooth Wilderness Area: vicinity of Alpine Lake, 44° 4' 02" north latitude; 115° 01' 16" west longitude. Elevation: 2548 m (8360 feet). Elemental analysis material reevaluated at this site, 24 August 1993.

SITE #3: 27 July 1988. Idaho, Elmore County, Sawtooth Wilderness Area: vicinity of North Alpine Basin, 43° 55' 55" north latitude; 115° 00' 53" west longitude. Elevation: 2591 m (8500 feet).

SITE #4: 28 July 1988. Idaho, Elmore County, Sawtooth Wilderness Area: vicinity of Flytrip Basin, 43° 55' 52" north latitude; 115° 00' 39" west longitude. Elevation: 2438 m (8000 feet).

SITE #5: 1 August 1989. Idaho, Elmore County, Sawtooth Wilderness Area: along Middle Fork of the Boise River, 43° 49" 23" north latitude; 115° 03' 44" west longitude. Elevation: 1722 m (5650 feet).

SITE #6: 2 August 1989. Idaho, Elmore County, Sawtooth Wilderness Area: along Queen's River Trail, 43° 51' 40" north latitude; 115° 10' 12" west longitude. Elevation: 1634 m (5360 feet).

METHODS

COLLECTION, CURATION, IDENTIFICATION, AND DEPOSITION OF LICHEN SPECIES:

Because lichen distribution is directly influenced by substrate, moisture and sunlight, all available substrates and habitats at each reference site were carefully examined. Small amounts of each lichen species were either removed directly from the substrate, or depending on the species, with a small amount of substrate (bark, wood, soil, or rock).

All specimens were placed in carefully labeled paper sacks and taken back to the BYU Herbarium of Nonvascular Cryptograms, where they were curated, identified, placed in permanent herbarium packets, and labeled with current epithets and authors' names as well as detailed information about the collection site, habitat, and substrate. Herbarium numbers (BRY C-) were also assigned.

Species were identified using standard lichen keys and taxonomic treatises. Standard chemical spot tests and, where necessary, thin-layer chromatography techniques were used to finalize species identifications.

One set of specimens collected from each reference site will be permanently housed at the BYU Herbarium of Nonvascular Cryptogams in Provo, Utah. A second set of voucher specimens will be sent to any herbarium designated by the U.S. Forest Service.

COLLECTION OF SENSITIVE INDICATOR SPECIES FOR ELEMENTAL ANALYSES:

After careful consideration of species abundance, available substrates, growth forms, documented/suspected pollution sensitivity and general distribution patterns, samples of one to several pollution sensitive indicator species were collected, returned to the Elemental Analysis Laboratory at BYU and PIXE analyses were performed.

At each reference site sufficient material of at least one sensitive, indicator species was collected for laboratory analysis (6-10 grams dry weight). All lichen material collected for elemental analyses was placed in Hubco cloth bags (to avoid contamination) and transported back to the BYU Herbarium of Nonvascular Cryptograms. Excess material is permanently stored in Hubco cloth bags in the elemental analysis collection at BYU. This material is available for additional testing upon request.

DETERMINATION OF ELEMENTAL CONCENTRATIONS IN LICHEN TISSUES:

In the laboratory, surface debris and dust were removed from all samples. Clean, two gram samples of at least one indicator species from each reference site were delivered to the Elemental Analysis Laboratory at Brigham Young University.

Samples were prepared for PIXE analysis using the methods of Duflou et al. (1987). Lichen samples were placed in Teflon containers with a teflon coated steel ball, cooled to liquid nitrogen temperature, powdered by brittle fracture using a Braun Mikro-Dismemberator II, and then dried in an Imperial IV Microprocessor Oven for 14 hours at 80°C. Subsamples weighing 150 mg were then weighed in to teflon containers and spiked with 1 ml of a 360 ppm yttrium solution. The samples were then oven dried again for 14 hours at 80°C. Samples were then homogenized again using the micro-dismemberator. Approximately 1 mg of the powdered lichen was then carefully weighed onto a thin polycarbonate film in an area of 0.5 cm^2. A 1.5% solution of polystyrene in toluene was used to secure the sample to the film.

Samples were analyzed using a 2 MV Van de Graaff accelerator with a 2.28 MeV proton beam which passed through a 1.1 mg/cm^2 pyrolytic graphite diffuser foil. The proton beam was collimated to irradiate an area of 0.38 cm^2 on the sample. Typically, 10-100 nA proton beam currents were used. X-rays were detected using a Tracor x-ray spectrometer, model TX-3/48-206, with a 10 mm^2 by 3 mm thick Si(Li) detector positioned at 90° to the proton beam. Samples were analyzed twice using different X-ray absorbers between the samples and the detector. One was a 49 mg/cm^2 Mylar absorber with a 0.27 mm^2 pinhole (2.8% of detector area). The Mylar was backed with 8.5 mg/cm^2 beryllium foil. A 98 mg/cm^2 Mylar absorber was also used.

To insure adequate quality control, samples of NIST SRM 1571, orchard leaves, and other standards were also prepared and analyzed using the same procedures.

RESULTS, OBSERVATIONS AND RECOMMENDATIONS

LICHEN MATERIAL COLLECTED FOR ELEMENTAL ANALYSES:

A total of 25 samples consisting of 5 species in 5 genera from three general substrates (conifer bark, conifer lignum and rock) were collected for elemental analyses. Proton Induced X-ray Emission (PIXE) techniques were used to analyze all samples. Below is a list of all of the elemental analysis samples by sample number (the first number represents the storage drawer and the second number represents the specimen bag number), species, substrate and reference site. All samples are stored in Hubco cloth bags in the Elemental Analysis Collection at the Herbarium of Non-vascular Cryptogams at Brigham Young University, Provo, Utah. Samples marked with an "*" were collected in 1993 as part of the reevaluation study at Farley and Alpine lakes.

Sample#	Taxa	Substrate	Reference site
13-106	Dermatocarpon reticulatum	rock	1
13-107	Letharia vulpina	conifer bark	1
13-108	Dermatocarpon reticulatum	rock	2
13-109	Letharia vulpina	conifer lignum	2
14-110	Dermatocarpon reticulatum	rock	3
14-111	Letharia vulpina	conifer bark	4
14-112	Bryoria fremontii	conifer bark	5
14-113	Letharia vulpina	conifer bark	5
14-114	Bryoria fremontii	conifer bark	5
14-115	Bryoria fremontii	conifer bark	5
14-116	Letharia vulpina	conifer bark	5
15-117	Letharia vulpina	conifer bark	5
18-146	Letharia vulpina	conifer bark	5
18-147	Bryoria fremontii	conifer bark	6
18-148	Tuckermannopsis canadensis	conifer bark	5
19-149	Bryoria fremontii	conifer bark	6
19-150	Tuckermannopsis canadensis	conifer bark	5
19-151	Letharia vulpina	conifer lignum	3
24-193*	Dermatocarpon reticulatum	rock	1
24-194*	Umbilicaria vellea	rock	1
24-195*	Letharia vulpina	conifer lignum	1
24-196*	Dermatocarpon reticulatum	rock	2
24-197*	Letharia vulpina	conifer bark	2
24-198*	Umbilicaria vellea	rock	2
29-241a	Letharia vulpina	conifer lignum	5
29-241b	Letharia vulpina	conifer lignum	5

POLLUTION SENSITIVE INDICATOR SPECIES BY REFERENCE SITE:

vicinity of Alpine Lake:

Bryoria abbreviata (sensitive to ozone)
Buellia punctata (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Melanelia exasperatula (intermediately sensitive to sulfur dioxide)
Melanelia subolivacea (intermediately sensitive to ozone)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Rhizocarpon geographicum (sensitive to flouride)

vicinity of Farley Lake:

Bryoria abbreviata (sensitive to ozone)
Buellia punctata (intermediately sensitive to sulfur dioxide)
Candelariella vitellina (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Letharia vulpina (intermediately sensitive to ozone)
Melanelia exasperatula (intermediately sensitive to sulfur dioxide)
Ochrolechia androgyna (sensitive to sulfur dioxide)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Platismatia glauca (intermediately sensitive to sulfur dioxide)
Pseudephebe pubescens (intermediately sensitive to ozone)
Rhizocarpon geographicum (sensitive to flouride)
Rhizoplaca chrysoleuca (sensitive to sulfur dioxide; sensitive to NO_X/PAN)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)
Xanthoria candelaria (intermediately sensitive to sulfur dioxide)

vicinity of North Alpine-Flytrip Basins:

Acarospora chlorophana (sensitive to sulfur dioxide)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Phaeophyscia orbicularis (sensitive ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia caesia (intermediately sensitive to sulfur dioxide)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Pseudephebe pubescens (intermediately sensitive to ozone)
Rhizocarpon geographicum (sensitive to flouride)
Rhizoplaca melanophthalma (sensitive to sulfur dioxide)

Middle Fork Boise River:

Alectoria sarmentosa (senstive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Buellia punctata (intermediately sensitive to sulfur dioxide)
Cladonia fimbriata (senstive to intermediately sensitive to sulfur dioxide)
Hypocenomyce scalaris (intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Lecanora saligna (intermediately sensitive to sulfur dioxide)
Leptochidium albocliatum (sensitive to intermediately sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Melanelia exasperatulai (intermediatelys sensitive to sulfur dioxide)
Ochrolechia androgyna (sensitive to sulfur dioxide)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Phaeophyscia orbicularis (sensitive to ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride)
Physcia dubia (senstive to intermediately sensitive to sulfur dioxide)
Pseudephebe pubescens (intermediately senstive to ozone)
Rhizocarpon disporum (sensitive to flouride)
Tuckermannopsis canadensis (sensitive to ozone)
Tuckermannopsis chlorophylla (sensitive to sulfur dioxide)
Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)
Xanthoria fallax (intermediately sensitive to sulfur dioxide; sensitive to NO_X/PAN)

along Queen's River Trail:

Alectoria sarmentosa (sensitive to ozone)
Bryoria abbreviata (sensitive to ozone)
Bryoria fremontii (sensitive to ozone)
Bryoria fuscescens (intermediately sensitive to sulfur dioxide)
Buellia punctata (intermediately sensitive to sulfur dioxide)
Calicium viride (sensitive to ozone; intermediately sensitive to sulfur dioxide)
Caloplaca cerina (sensitive to intermediately sensitive to sulfur dioxide)
Candelariella vitellina (intermediately sensitive to sulfur dioxide; sensitive to flouride)
Cladonia fimbriata (sensitive to intermediately sensitive to sulfur dioxide)
Hypogymnia imshaugii (intermediately sensitive to ozone)
Letharia columbiana (intermediately sensitive to ozone)
Letharia vulpina (intermediately sensitive to ozone)
Melanelia subolivacea (intermediately sensitive to ozone)
Ochrolechia androgyna (sensitive to sulfur dioxide)
Parmeliopsis ambigua (intermediately sensitive to sulfur dioxide)
Parmeliopsis hyperopta (intermediately sensitive to sulfur dioxide)
Peltigera canina (sensitive to ozone)
Physcia dubia (sensitive to intermediately sensitive to flouride)
Rhizocarpon geographicum (sensitive to flouride)
Tuckermannopsis merrillii (sensitive to intermediately sensitive to ozone)
Usnea subfloridana (sensitive to intermediately sensitive to sulfur dioxide)
Xanthoria candelaria (intermediately sensitive to sulfur dioxide)

CHECKLIST OF LICHEN SPECIES FROM SAWTOOTH WILDERNESS AREA:

Acarospora chlorophana (Wahlenb. *ex* Ach.) Massal.
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31425

Acarospora fuscata (Nyl.) Arnold
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31426

Alectoria sarmentosa (Ach.) Ach.
Growth form: Fruticose
Substrate: Douglas Fir
Site(s): along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common to abundant
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31308, BRY C-31410

Aspicilia alphoplaca (Wahlenb. *in* Ach.)Poelt & Leuck.
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31362

Aspicilia cinerea (L.) Körber
Growth form: Crustose
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31379

Aspicilia desertorum (Krempelh.) Mereschk.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31430

Bellemerea alpina (Sommerf.) Clauz. & Roux
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31428, BRY C-31481, BRY C-32153

Bellemerea cinereorufescens (Ach.) Clauz. & Roux
Growth form: Crustose
Substrate: rock
Site(s): Middle Fork Boise River, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31370, BRY C-32154

Biatora vernalis (L.) Fr.
Growth form: Crustose
Substrate: conifer bark, lignum
Site(s): vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BYU Herbarium: BRY C-31306, BRY C-31395

Brodoa oroarctica (Krog) Goward
Growth form: Foliose
Substrate: rock
Site(s): vicinity of north Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31431

Bryoria abbreviata (Müll. Arg.) Brodo & D. Hawksw.
Growth form: Fruticose
Substrate: Lodgepole Pine bark, Douglas Fir
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31329, BRY C-31404, BRY C-32152, BRY C-32153, BRY C-32156

Bryoria fremontii (Tuck.) Brodo & D. Hawksw.
Growth form: Fruticose
Substrate: Douglas Fir, Lodgepole Pine
Site(s): along Queen's River Trail, Middle Fork Boise River
Relative abundance: common to locally abundant
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31421, BRY C-31352, BRY C-31403

Bryoria fuscescens (Gyelnik) Brodo & C. Hawksw.
Growth form: Fruticose
Substrate: conifer bark
Site(s): along Queen's River Trail
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32162

Buellia punctata (Hoffm.) Massal.
Growth form: Crustose
Substrate: lignum, Douglas Fir
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31309a, BRY C-31309b, BRY C-31393

Calicium viride Pers.
Growth form: Crustose
Substrate: Douglas Fir
Site(s): along Queen's River Trail
Relative abundance: rare
Pollution sensitivity: sensitive to ozone; intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31311

Caloplaca cerina (Ehrh. *ex* Hedwig) Th. Fr.
Growth form: Crustose (absent)
Substrate: Aspen
Site(s): along Queen's River Trail
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BYU Herbarium: BRY C-32161

Caloplaca epithallina Lynge
Growth form: Crustose
Substrate: epiphytic, growing over other lichens
Site(s): vicinity of Flytrip Basin Pass
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31427b

Caloplaca holocarpa (Hoffm.) Wade
Growth form: Crustose (absent)
Substrate: Douglas Fir
Site(s): vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-32157

Caloplaca jungermanniae (Vahl) Th. Fr.
Growth form: Crustose (absent)
Substrate: detritus
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31433

Caloplaca stillicidiorum (Vahl) Lynge
Growth form: Crustose
Substrate: moss over soil
Site(s): along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31318

Caloplaca tiroliensis Zahlbr.
Growth form: Crustose
Substrate: detritus, moss over rock
Site(s): vicinity of Flytrip Basin Pass, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31373

Candelariella rosulans (Müll. Arg.) Zahlbr.
Growth form: Crustose
Substrate: rock, soil, moss over rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31434

Candelariella vitellina (Hoffm.) Müll
Growth form: Crustose
Substrate: Douglas Fir
Site(s): vicinity of Farley Lake, along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide; sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32161, BRY C-32163

Catapyrenium squamulosum (Ach.) Breuss
Growth form: Squamulose
Substrate: soil
Site(s): vicinity of North Alpine Basin
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31435

Cladonia cervinornis (Ach.) Flotow subsp. verticillata (Hoffm.) Ahti
Growth form: Squamulose (with podetia)
Substrate: soil
Site(s): along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32158

Cladonia chlorophaea (Flörke *ex* Sommerf.)
Growth form: Squamulose (with Podetia)
Substrate: soil
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31485

Cladonia deformis (L.) Hoffm.
Growth form: Squamulose (with podetia)
Substrate: detritus
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31343

Cladonia fimbriata (L.) Fr.
Growth form: Squamulose (with podetia)
Substrate: decomposing wood, Douglas Fir, moss over soil, soil, moss
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: sensitive to intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31305, BRY C-31355, BRY C-31419, BRY C-31483, BRY C-31484, BRY C-32157, BRY C-32162

Cladonia pocillum (Ach.) O. Rich
Growth form: Squamulose (with podeitia)
Substrate: soil
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31436

Cladonia pyxidata (L.) Hoffm.
Growth form: Squamulose
Substrate: soil, bark
Site(s): vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-32164

Cyphelium tigillare (Ach.) Ach.
Growth form: Crustose
Substrate: Douglas Fir, burned wood, lignum
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31353, BRY C-31413, BRY C-31437, BRY C-32163

Dermatocarpon miniatum (L.) Mann
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake, vicinity of North Alpine-Flytrip Basins, Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31372, BRY C-31439

Dermatocarpon reticulatum Magnusson
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31486, BRY C-32165

Hypocenomyce scalaris (Ach. *ex* Liljeblad) M. Choisy
Growth form: Squamulose
Substrate: burned wood
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31412

Hypogymnia imshaugii Krog
Growth form: Foliose
Substrate: conifer bark, Douglas Fir
Site(s): vicinity of Alpine Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31303, BRY C-31335, BRY C-31347, BRY C-32164

Lecanora argentata (Ach.) Malme
Growth form: Crustose
Substrate: Douglas Fir
Site(s): Middle Fork Boise River, along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31416, BRY C-32165

Lecanora argopholis (Ach.) Ach.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine Basin, vicinity of Flytrip Basin Pass, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31390

Lecanora cenisia Ach.
Growth form: Crustose
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins
Relatie abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31322, BRY C-31377, BRY C-31444

Lecanora christoi W. Weber
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31394

Lecanora hageni (Ach.) Ach.
Growth form: Crustose (absent)
Substrate: over Selaginella, lignum, detritus, polypore
Site(s): vicinity of North Alpine-Flytrip Basins, along Queen's River Trail
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31445, BRY C-31448, BRY C-32168

Lecanora impudens Degel.
Growth form: Crustose
Substrate: lignum, Douglas Fir
Site(s): vicinity of Farley Lake, vicinity of Alpine Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31496, BRY C-32160

Lecanora muralis (Schreber) Rabenh.
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31424, BRY C-31378

Lecanora novomexicana (B. de Lesd.) Zahlbr.
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of sepcimens: BYU Herbarium: BRY C-31442, BRY C-32169

Lecanora polytropa (Hoffm.) Rabenh.
Growth form: Crustose (absent)
Substrate: rock, soil over rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31423, BRY C-31383, BRY C-31441, BRY C-31490, BRY C-32168

Lecanora pseudomellea Ryan
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31447

Lecanora rupicola (L.) Zahlbr.
Growth form: Crustose (absent)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31449

Lecanora saligna (Shrader)
Growth form: Crustose
Substrate: conifer bark, lignum
Site(s): Middle Fork Boise River, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31331, BRY C-31332

Lecanora sierrae Ryan
Growth form: Crustose (with effigurate margins)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31443

Lecanora varia (Hoffm.) Ach.
Growth form: Crustose (absent)
Substrate: lignum, Douglas Fir
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31313, BRY C-31375, BRY C-31488, BRY C-32170

Lecidea atrobrunnea (Ramond *in* Lam. & DC.) Schaerer
Growth form: Crustose
Substrate: rock
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake, vicinity of North Alpine-Flytrip Basins, along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31320, BRY C-31364, BRY C-31454, BRY C-31489, BRY C-32173

Lecidea tessellata Flörke
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basin, vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31324, BRY C-31374, BRY C-31451, BRY C-31491, BRY C-32174

Lecidea turgidula Fr.
Growth form: Crustose
Substrate: conifer bark
Site(s): vicinity of North Alpine Basin, vicinity of Farley Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31450

Lecidella euphorea (Flörke) Hertel
Growth form: Crustose
Substrate: lignum, Douglas Fir
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31455, BRY C-31492, BRY C-32176, BRY C-32177

Lecidella stigmatea (Ach.) Hertel & Leuck.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake, vicinity of North Alpine-Flytrip Basins, along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimen: BYU Herbarium: BRY C-31325, BRY C-31432, BRY C-32175

Lepraria neglecta (Nyl.) Lettau
Growth form: Crustose
Substrate: soil
Site(s): vicinity of North Alpine Basin
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31456

Leptochidium albociliatum (Desmaz.) M. Choisy
Growth form: Foliose
Substrate: moss over rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31358

Letharia columbiana (Nutt.) Thomson
Growth form: Fruticose
Substrate: Lodgepole Pine, lignum, Douglas Fir
Site(s): vicinity of North Alpine-Flytrip Basins, along Queen's River Trail, Middle Fork Boise River, vicinity of Alpine Lake
Relative abundance: common to locally abundant
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31300, BRY C-31405, BRY C-31458, BRY C-31494, BRY C-32167

Letharia vulpina (L.) Hue
Growth form: Fruticose
Substrate: Douglas Fir, lignum
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River Trail, Middle Fork Boise River
Relative abundance: common to abundant
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31301, BRY C-31333, BRY C-31356, BRY C-31457, BRY C-31493, BRY C-32166, BRY C-32178

Melanelia exasperatula (Nyl.) Essl.
Growth form: Foliose
Substrate: lignum, Douglas Fir
Site(s): vicinity of Alpine Lake, Middle Fork Boise River, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31386, BRY C-31392, BRY C-31417, BRY C-31498, BRY C-32180, BRY C-32181

Melanelia granulosa (Lynge) Essl.
Growth form: Foliose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31409, BRY C-31460

Melanelia elegantula (Zahlbr.) Essl.
Growth form: Foliose
Substrate: moss over rock, conifer branches
Site(s): Middle Fork Boise River, vicinity of Alpine Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31351, BRY C-31495

Melanelia exasperatula (Nyl.) Essl.
Growth form: Foliose
Substrate: Douglas Fir, Aspen
Site(s): along Queen's River Trail
Relative abundance:
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments:
Deposition of specimens: BYU Herbarium: BRY C-32169, BRY C-32170

Melanelia sorediata (Ach.) Goward & Ahti
Growth form: Foliose
Substrate: rock
Site(s): vicinity of Farley Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32179

Melanelia subolivacea (Nyl. *in* Hasse) Essl.
Growth form: Foliose
Substrate: conifer bark, lignum
Site(s): along Queen's River Trail, vicinity of Alpine Lake
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31302, BRY C-31497

Micarea assimilata (Nyl.) Coppins
Growth form: Crustose
Substrate: detritus
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31340

Mycobilimbia berengeriana (Massal.) Gafellner & V. Wirth *in* V. Wirth
Growth form: Crustose
Substrate: detritus
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31346

Nephroma parile (Ach.) Ach.
Growth form: Foliose
Substrate: rock, moss over soil, Douglas Fir, moss over rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31339, BRY C-31341, BRY C-31345, BRY C-31411

Ochrolechia androgyna (Hoffm.) Arnold
Growth form: Crustose
Substrate: conifer bark, Douglas Fir
Site(s): Middle Fork Boise River, vicinity of Farley Lake, along Queen's River Trail
Relative abundance: rare
Pollution sensitivity: sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31389, BRY C-32173, BRY C-32196

Pannaria leucophaea (Vahl) P.Jorg.
Growth form: Squamulose
Substrate: soil over rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31354

Parmelia saxatilis (L.) Ach.
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31396

Parmeliopsis ambigua (Wulfen *in* Jacq.) Nyl.
Growth form: Foliose
Substrate: Douglas Fir, lignum
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31311, BRY C-31312, BRY C-31391, BRY C-31459, BRY C-31499, BRY C-32182

Parmeliopsis hyperopta (Ach.) Arnold
Growth form: Foliose
Substrate: conifer bark
Site(s): along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31307

Peltigera aphthosa (L.) Willd.
Growth form: Foliose
Substrate: soil, moss/soil over rock
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31397, BRY C-31407, BRY C-31461

Peltigera canina (L.) Willd.
Growth form: Foliose
Substrate: soil, mossy soil
Site(s): Middle Fork Boise River, vicinity of Alpine Lake, vicinity of Farley Lake, along Queen's River Trail
Relative abundance: locally common
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31399, BRY C-32149, BRY C-32172, BRY C-32184

Peltigera malacea (Ach.) Funck
Growth form: Foliose
Substrate: mossy soil, soil
Site(s): vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32148, BRY C-32185

Peltigera rufescens (Weis) Humb.
Growth form: Foliose
Substrate: soil
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31462

Phaeophyscia endococcina (Körber) Moberg
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31384, BRY C-32186

Phaeophyscia orbicularis (Necker) Moberg
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: sensitive ozone; intermediately sensitive to sulfur dioxide; sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31371, BRY C-31465

Physcia caesia (Hoffm.) Fürnr.
Growth form: Foliose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31463, BRY C-32187

Physcia dubia (Hoffm.) Lettau
Growth form: Foliose
Substrate: rock, burned wood
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31321, BRY C-31365, BRY C-31414, BRY C-31464, BRY C-32188

Psora nipponica (Zahlbr.) G. Schneider
Growth form: Squamulose
Substrate: soil
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31342

Psoroma hypnorum (Vahl) Gray
Growth form: Squamulose
Substrate: moss over soil
Site(s): along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31317

Rhizocarpon disporum (Naeg. *ex* Hepp) Müll
Growth form: Crustose
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31420, BRY C-31363, BRY C-31467, BRY C-32190

Rhizocarpon geographicum (L.) DC.
Growth form: Crustose
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: common to abundant
Pollution sensitivity: sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31422, BRY C-31366, BRY C-31469, BRY C-32150, BRY C-32191

Rhizocarpon simillimum (Anzi) Lettau
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31470

Physcia phaea (Tuck.) Thomson
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31400

Physconia muscigena (Ach.) Poelt
Growth form: Foliose
Substrate: moss over rock, moss
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31360, BRY C-31466

Platismatia glauca (L.) Culb. & C. Culb.
Growth form: Foliose
Substrate: Douglas Fir
Site(s): vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32183

Polychidium muscicola (Swartz) Gray
Growth form: Foliose
Substrate: moss over rock, rock
Site(s): along Queen's River Trail, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31319, BRY C-31398

Protoparmelia badia (Hoffm.)Hafellner
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31446

Pseudephebe pubescens (L.) M. Choisy
Growth form: Fruticose
Substrate: rock
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: intermediately senstive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31350, BRY C-31440, BRY C-32189

Rhizocarpon superficiale (Schaerer) Vainio
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31468

Rhizoplaca chrysoleuca (Sm.) Zopf
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide; sensitive to NO_x/PAN (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32193

Rhizoplaca melanophthalma (DC. *in* Lam. & DC.) Leuck. & Poelt
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31471, BRY C-32192

Rhizoplaca peltata (Ramond) Leuck. & Poelt
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31367

Rinodina milvina (Wahlenb. *in* Ach.) Th. Fr.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of Farley Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32194

Schaereria cinereorufa (Schaerer) Th. Fr.
Growth form: Squamulose
Substrate: soil over rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31344

Physcia phaea (Tuck.) Thomson
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31400

Physconia muscigena (Ach.) Poelt
Growth form: Foliose
Substrate: moss over rock, moss
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31360, BRY C-31466

Platismatia glauca (L.) Culb. & C. Culb.
Growth form: Foliose
Substrate: Douglas Fir
Site(s): vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Wetmore 1987)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32183

Polychidium muscicola (Swartz) Gray
Growth form: Foliose
Substrate: moss over rock, rock
Site(s): along Queen's River Trail, Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31319, BRY C-31398

Protoparmelia badia (Hoffm.)Hafellner
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31446

Pseudephebe pubescens (L.) M. Choisy
Growth form: Fruticose
Substrate: rock
Site(s): Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: intermediately senstive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31350, BRY C-31440, BRY C-32189

Psora nipponica (Zahlbr.) G. Schneider
Growth form: Squamulose
Substrate: soil
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31342

Psoroma hypnorum (Vahl) Gray
Growth form: Squamulose
Substrate: moss over soil
Site(s): along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31317

Rhizocarpon disporum (Naeg. *ex* Hepp) Müll
Growth form: Crustose
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31420, BRY C-31363, BRY C-31467, BRY C-32190

Rhizocarpon geographicum (L.) DC.
Growth form: Crustose
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake, vicinity of Farley Lake
Relative abundance: common to abundant
Pollution sensitivity: sensitive to flouride (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31422, BRY C-31366, BRY C-31469, BRY C-32150, BRY C-32191

Rhizocarpon simillimum (Anzi) Lettau
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31470

Rhizocarpon superficiale (Schaerer) Vainio
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31468

Rhizoplaca chrysoleuca (Sm.) Zopf
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide; sensitive to NO_X/PAN (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32193

Rhizoplaca melanophthalma (DC. *in* Lam. & DC.) Leuck. & Poelt
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31471, BRY C-32192

Rhizoplaca peltata (Ramond) Leuck. & Poelt
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31367

Rinodina milvina (Wahlenb. *in* Ach.) Th. Fr.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of Farley Lake
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32194

Schaereria cinereorufa (Schaerer) Th. Fr.
Growth form: Squamulose
Substrate: soil over rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31344

Sporastatia testudinea (Ach.) Massal.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31472

Staurothele drummondii (Tuck.) Tuck.
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31473

Tephromela armeniaca (DC.) Hertel
Growth form: Crustose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31452

Trapeliopsis granulosa (Hoffm.) Lumbsch.
Growth form: Crustose
Substrate: lignum, humic soil
Site(s): along Queen's River Trail, Middle Fork Boise River
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31330, BRY C-31418

Tuckermannopsis canadensis (Räsänen) Hale
Growth form: Foliose
Substrate: Lodgepole Pine
Site(s): Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31334, BRY C-31402

Tuckermannopsis chlorophylla (Willd. *in* Humb.) Hale
Growth form: Foliose
Substrate: conifer bark
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments:
Deposition of specimens: BYU Herbarium: BRY C-31387

Tuckermannopsis merrillii (Du Rietz) Hale
Growth form: Fruticose
Substrate: Lodgepole Pine
Site(s): Middle Fork Boise River, along Queen's River Trail
Relative abundance: rare
Pollution sensitivity: sensitive to intermediately sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31388, BRY C-31406, BRY C-32174

Tuckermannopsis platyphylla (Tuck.) Hale
Growth form: Foliose
Substrate: Douglas Fir
Site(s): along Middle Fork of Boise River, along Queen's River Trail
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32154, BRY C-32160

Umbilicaria americana sp. nov.
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of spcimens: BYU Herbarium: BRY C-31359

Umbilicaria hyperborea (Ach.) Hoffm.
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): along Queen's River Trail, Middle Fork Boise River, vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31315, BRY C-31338, BRY C-31348, BRY C-31415, BRY C-31476, BRY C-32197

Umbilicaria krascheninnikovii (Savicz) Zahlbr.
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Farley Lake
Relative abundance: rare to locally common
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31475, BRY C-32198

Umbilicaria torrefacta (Lightf.) Scharader
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31349

Umbilicaria vellea (L.) Ach.
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins, vicinity of Alpine Lake
Relative abundance: rare to locally abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31438, BRY C-32151

Umbilicaria virginis Schaerer
Growth form: Foliose (umbilicate)
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common to abundant
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31474

Usnea hirta (L.) Weber *ex* Wigg.
Growth form: Fruticose
Substrate: conifer bark
Site(s): Middle Fork Boise River
Relative abundance: rare
Pollution sensitivity: sensitive to ozone (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31369

Usnea subfloridana Stirton
Growth form: Fruticose
Substrate: conifer bark
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to intermediately senstive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31368

Xanthoparmelia coloradoensis (Gyelnik) Hale
Growth form: Foliose
Substrate: rock, detritus
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31477, BRY C-31478

Xanthoparmelia cumberlandia (Gyelnik) Hale
Growth form: Foliose
Substrate: rock
Site(s): Middle Fork Boise River
Relative abundance: rare to locally common
Pollution sensitivity: sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31361

Xanthoria candelaria (L.) Th. Fr.
Growth form: Foliose
Substrate: Douglas Fir, Aspen
Site(s): vicinity of Farley Lake, along Queen's River Trail
Relative abundance: rare
Pollution sensitivity: intermediately sensitive to sulfur dioxide (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-32159, BRY C-32171, BRY C-32199

Xanthoria elegans (Link.) Th. Fr.
Growth form: Foliose
Substrate: rock
Site(s): vicinity of North Alpine-Flytrip Basins
Relative abundance: locally common
Pollution sensitivity : Unknown
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31479

Xanthoria fallax (Hepp *in* Arnold)
Growth form: Foliose
Substrate: lignum
Site(s): Middle Fork Boise River
Relative abundance: locally common
Pollution sensitivity: intermediately sensitive to sulfur dioxide; sensitive to NO_X/PAN (Ryan 1990)
Comments: none
Deposition of specimens: BYU Herbarium: BRY C-31337

OBSERVATIONS:

1. Collections made during the summers of 1988 and 1989 included a diverse group of lichen species. The flora includes a total of 118 species in 54 genera. All growth forms in the wilderness area are well represented; however the flora is dominated by crustose species (44%, 52 species), followed by foliose species (37%, 44 species). Fruticose lichens represent 9% (10 species) while squamulose species comprise 10% (12 species) of the flora. This growth form pattern is typical of the Intermountain Area. Comparing favorably with other Intermountain Area lichen floras which are typically dominated by crustose species (48% in the Bridger Wilderness Area (Wyoming), and 50% in the High Uintas Wilderness Area (Utah); with foliose species representing only 28% and 29% of these floras respectively. The higher percentage of foliose species in the Sawtooth Wilderness Area (36%) is largely due to a Pacific Northwest influence on the two reference sites located on the west side of the wilderness area {reference site #5 (along the Middle Fork of the Boise River) and reference site #6 (along Queen's River Trail)}.

2. During this study lichens were collected from 5 basic substrates: rocks, lignum/bark, moss/detritus, soil, and lichen thalli. A total of 55 species (46% of the flora) were collected from rock substrates. Bark and lignum substrates were second in importance accounting for 37 species (31% of the flora). Fourteen species (12% of the flora) were collected from moss or detritus, with 11 species (10% of the flora) from the soil and one species (<1%) growing over other lichen thalli. This substrate pattern is also more typical of Intermountain Area lichen communities, where various rock substrates support abundant lichen growth. The influence of regional weather patterns, along with the occurrence of well-developed, suitable microhabitats and the dispersal of asexual/sexual propagules by prevailing winds has effectively accomodated the movement of some Pacific Northwest, corticolous lichen species into the two reference sites on the west side of the wilderness.

3. High species diversity as well as an abundance of all basic growth forms (especially the more pollution sensitive foliose and fruticose species) indicates that the lichen communities in the Sawtooth Wilderness Area are healthy and have not been impacted by air pollution.

4. The abundance of sensitive indicator species at all reference sites {vicinity of Alpine Lake (11 spp.), vicinity of Farley Lake (17 spp.), vicinity of North Alpine-Flytrip basins (10 spp.), Middle Fork of the Boise River (23 spp.), and Queen's River (22 spp.)} further documents that the lichen flora in the wilderness area is healthy and unimpacted by air pollution. The higher number of sensitive indicator species from the western side of the wilderness (23 and 22 spp. respectively) again reflects the the Pacific Northwest influence, manifested specifically in terms of higher numbers of fruticose and foliose species.

5. The general absence of necrotic and/or bleached thalli also suggests that the lichen flora is unimpacted.

6. Baseline concentrations of potential pollutant elements were determined by analyzing the tissues of at least one sensitive indicator species from each reference site (table 1). Thallus concentrations of all potential pollutant elements are well within background levels* (figure 2). *note: as indicated in my earlier report (1989) the high sulfur values for *Dermatocarpon miniatum* are most likely due to the fact that this species seems to preferentially occupy substrates that are inherently high in sulfur. Thus, the high sulfur values for this species reflects substrate contamination, and not air pollution impact. This conclusion is further substantiated by the much lower sulfur values obtained for the other sensitive indicator species. Discrepancies between the 1988 values for lead and copper and the 1993 values for those same elements is likely due to differences in the detectability limits of the two analysis techniques. The 1988 and 1989 samples are currently being reevaluated using PIXE technology. This should clear up the discrepancies, plus give us better resolution with the 1988 and 1989 material along with baseline data for the other 17 potential pollutant elements.

RECOMMENDATIONS:

1. Eventually, 2 additional reference sites should be established along the northern boundary of the wilderness area (possibly, accessing the wilderness from Stanley Lake, and Grandjean trailheads). One additional site should also be established along the western boundary of the wilderness (possibly, along the North Fork of the Boise River from Graham Trailhead). These additional sites will provide a more complete bimonitoring network as well as further information about the lichen flora and additional baseline information about the status of sensitive indicator species. Reevaluation of the sensitive indicator species from the two 1989 reference sites (sites 5 and 6) should be performed within the next one to two years.

TABLE #1: Mean concentrations of potential pollutant elements in sensitive indicator species from air quality biomonitoring reference sites in the Sawtooth National Recreation Area. Values for 1988 and 1993 are shown.

Species and Collection Site	Elements (ppm except where indicated)										
	S%									Cu	
	1988	1993	Cl	K%	Ca%	Ti	V	Cr	Ni	1988	1993
Dermatocarpon miniatum, Farley Lake, Sample #193	0.476	0.24	360	0.6	0.1	210	2	5	4	7.7	6
Umbilicaria vellea, Farley Lake, Sample #194	n.d.	0.146	300	5.2	0.54	89	3	n.d.	n.d.	n.d.	7
Letharia vulpina, Farley Lake, Sample #195	0.179	0.062	250	2.2	5.6	60	n.d.	n.d.	n.d.	2	3
Dermatocarpon miniatum, Alpine Lake, Sample #196	0.276	0.19	290	6.1	0.93	103	n.d.	n.d.	n.d.	21.3	6.8
Letharia vulpina, Alpine Lake, Sample #197	0.118	0.052	230	2.8	5.7	35	n.d.	n.d.	n.d.	4.8	2.2
Umbilicaria vellea, Alpine Lake, Sample #198	n.d.	0.1	320	5.5	0.9	120	n.d.	n.d.	3	n.d.	5

TABLE #1: Continued

Species and Collection Site	Elements (ppm except where indicated)										
	Zn	Pb 1988	Pb 1993	Mn	Fe	Co	As	Se	Br	Rb	Sr
Dermatocarpon miniatum, Farley Lake, Sample #193	66	102.5	10	200	2200	n.d.	n.d.	0.7	33	23	15
Umbilicaria vellea, Farley Lake, Sample #194	109	n.d.	7	29	830	n.d.	1.68	n.d.	21	24	8
Letharia vulpina, Farley Lake, Sample #195	23	10.2	8	97	230	n.d.	1.1	n.d.	9	4	22
Dermatocarpon miniatum, Alpine Lake, Sample #196	25	10.2	4.7	57	920	n.d.	1	n.d.	16	10.6	11
Letharia vulpina, Alpine Lake, Sample #197	39	18.1	n.d.	190	190	1	1.5	n.d.	11	4	26
Umbilicaria vellea, Alpine Lake, Sample #198	250	n.d.	4	56	1300	n.d.	2.2	n.d.	18	21	9

Fig. 2 Lichen Biomonitoring Program and Baseline

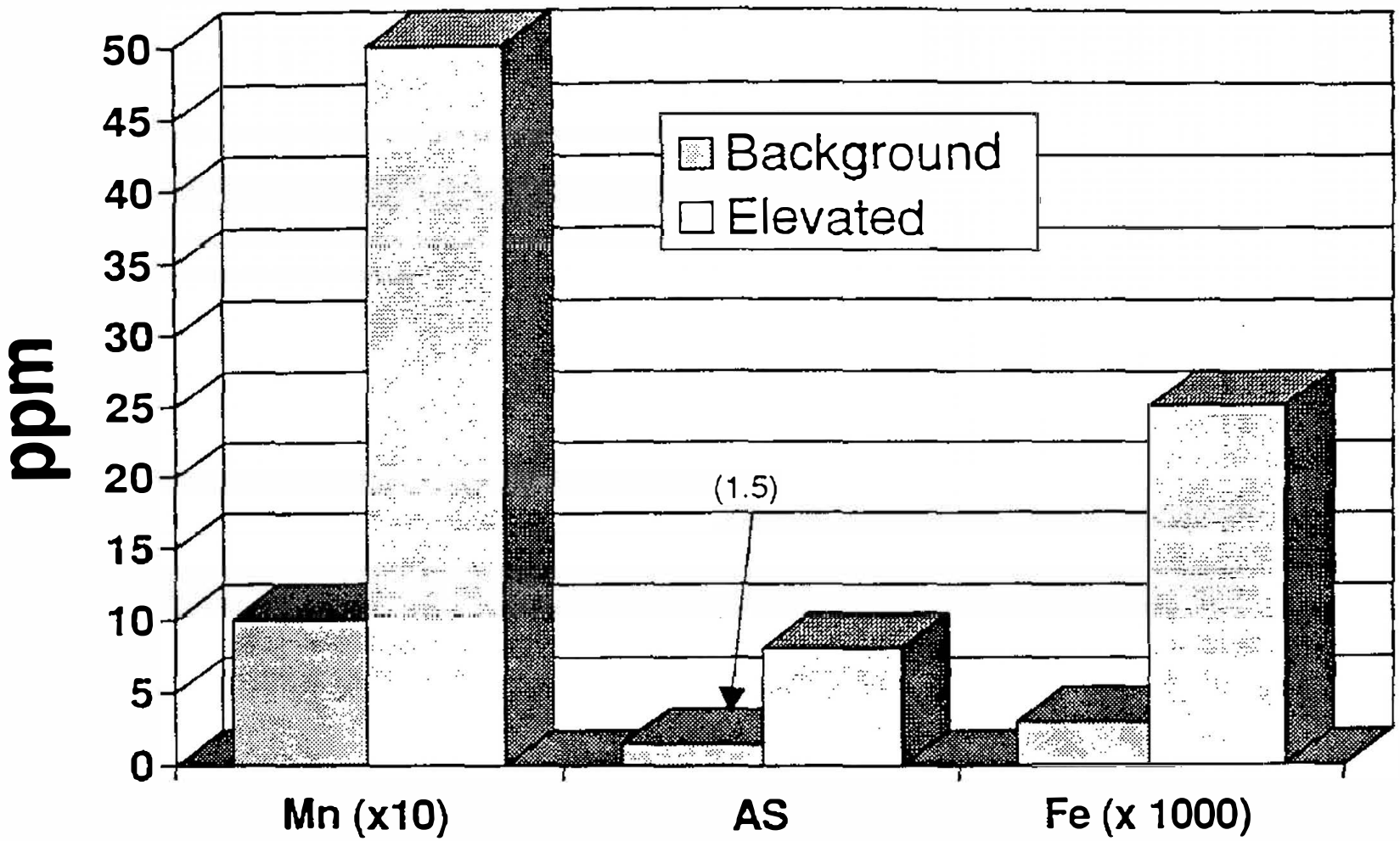


Fig. 2 cont. Lichen Biomonitoring Program and Baseline

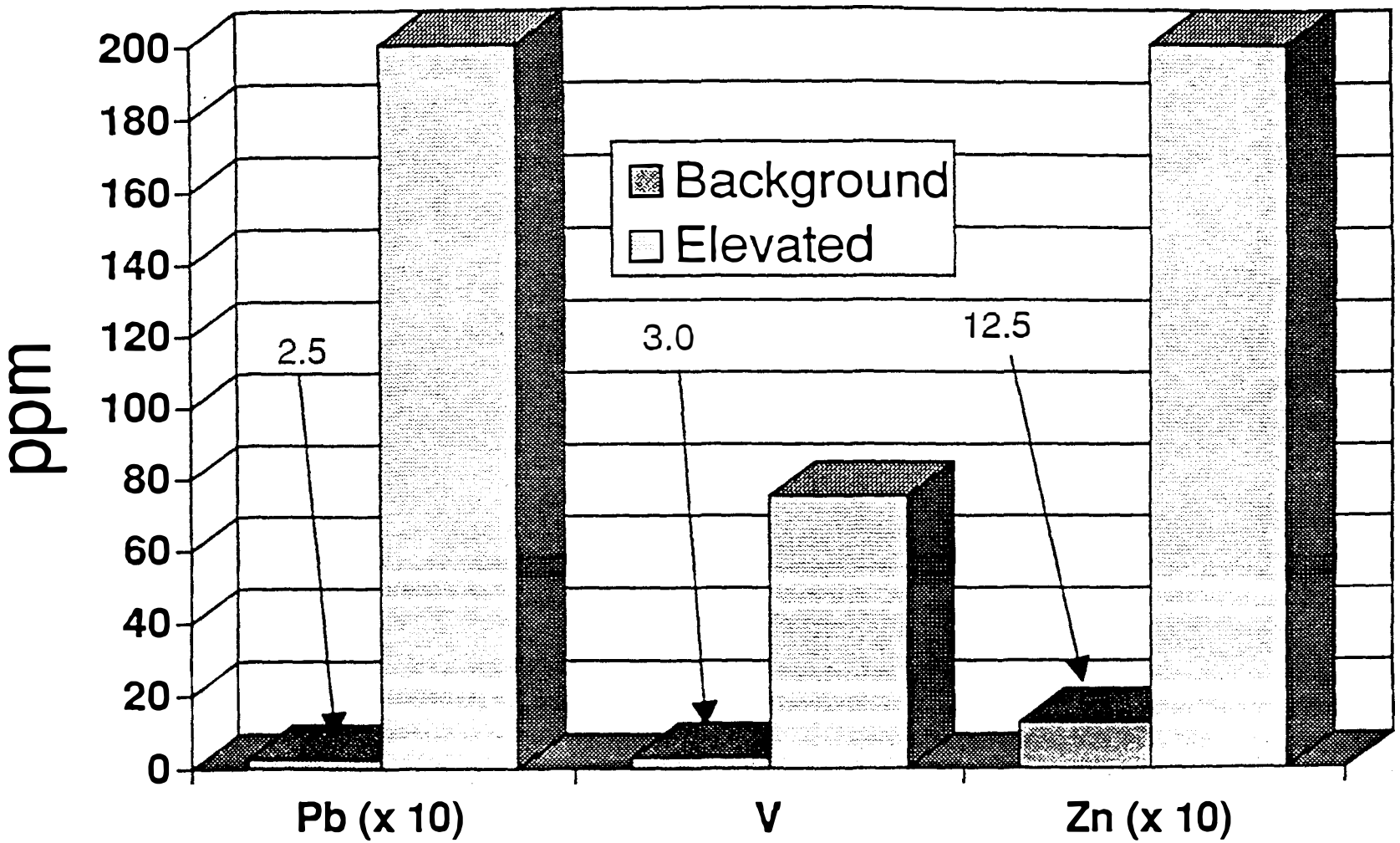
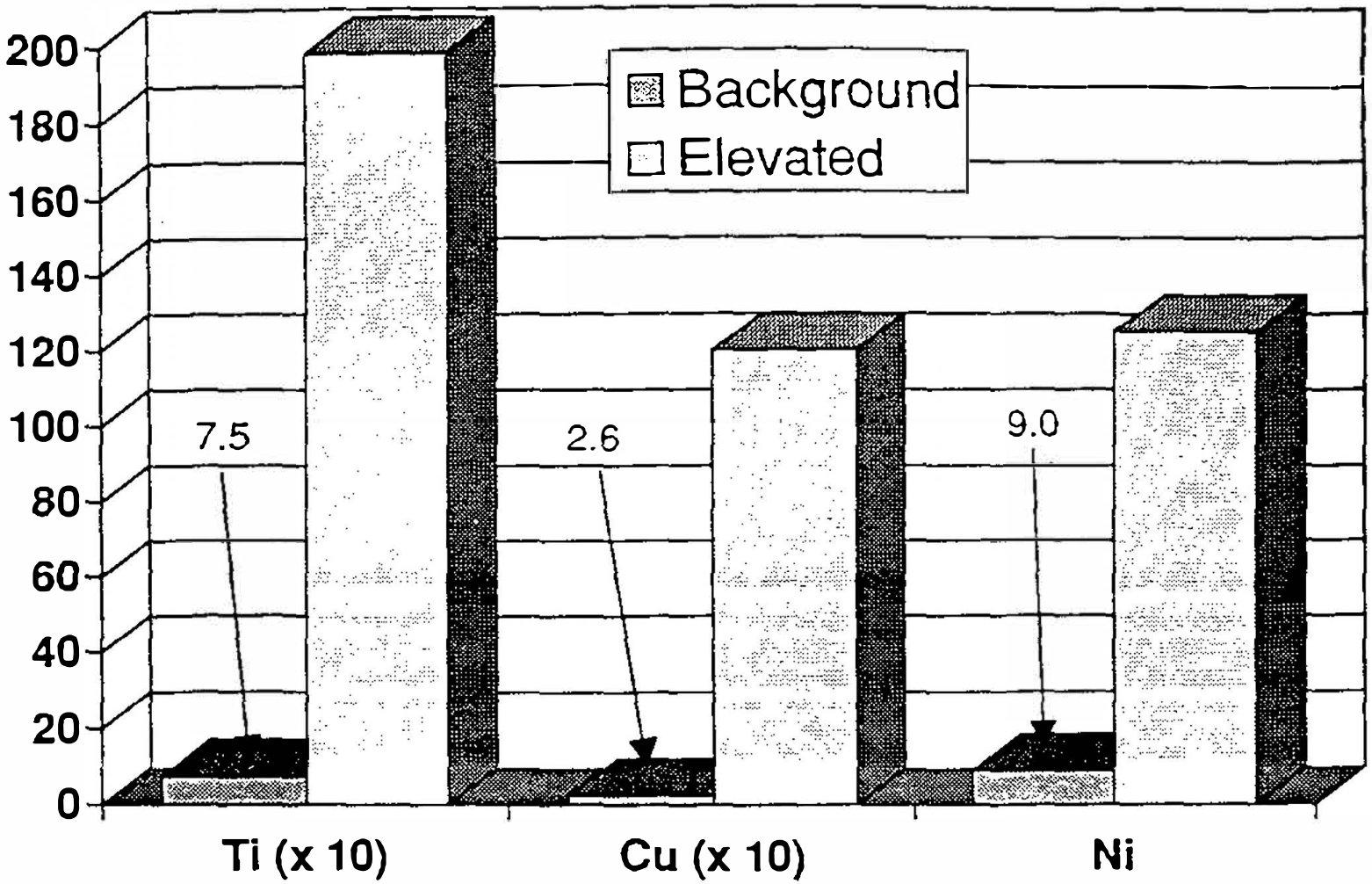


Fig. 2 cont. Lichen Biomonitoring Program and Baseline



2. Generally, re-evaluation of sensitive indicator species should be performed every 5 to 8 years, depending on significant changes in either local or regional air pollution patterns. The development of new air pollution sources in close proximity to the wilderness area would also be a significant factor in determining the timing of followup surveys.

3. Re-evaluation of the lichen flora at existing reference sites is generally unnecessary, unless sensitive indicator species begin to show either significantly higher levels of pollutant elements or substantial changes in relative abundance.

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